Amendments to the Specification:

Please delete the previous first paragraph beginning at page 1, line 1 of the original specification in favor of the new first paragraph provided in the preliminary amendment filed on July 13, 2003.

Please replace the paragraph, beginning at page 2, line 13, with the following rewritten paragraph:

In conventional systems the vision system (shown in Fig. 11) consists of two image devices, a first image device 1104 placed below ~~the optical~~workpiece plane 1112 and upwardly viewing objects and a second image device 1102 placed above ~~the optical~~workpiece plane 1112 and downwardly viewing objects. These conventional systems have drawbacks in that in addition to requiring more than one image device, they are unable to easily compensate for variations in the system due to thermal changes, for example.

Please replace the paragraph, beginning at page 2, line 25, with the following rewritten paragraph:

The present invention is a vision system for use with a semiconductor fabrication machine for accurate die alignment and die placement. The system comprises an alignment tool having a plurality of internal reflection surfaces, the alignment tool located below ~~a vision~~ an object plane of the substrate (or other workpiece); and an optical detector to receive an indirect image of a bottom surface of the ~~die~~ substrate through the alignment tool.

Please replace the paragraph, beginning at page 3, line 14, with the following rewritten paragraph:

According to a further aspect of the present invention, the first lens and the second lens are located at or below the ~~imagevision~~object plane.

Please replace the paragraph, beginning at page 3, line 16, with the following rewritten paragraph:

According to another aspect of the present invention, the first lens and the second lens are located in line with the ~~image~~<u>vision</u> plane.

Please replace the paragraph, beginning at page 4, line 3, with the following rewritten paragraph:

According to an exemplary method of the present invention, a cornercube offset tool is positioned below a ~~vision~~<u>workpiece</u> plane of the die; a lens is positioned between i) the die and the cornercube offset tool and ii) between an optical imager and the cornercube offset tool; and the die is viewed indirectly through the cornercube offset tool and the lens.

Please replace the paragraph, beginning at page 5, line 21, with the following rewritten paragraph:

Referring to Fig. 1 a perspective view of an exemplary embodiment of the present invention is shown. The system is included in wire bonding machine 100, and employs a cornercube 106, having a plurality of internal reflection surfaces (best shown in Fig. 6), located at or below ~~image~~ <u>object</u> plane 112<u>A</u> of bonding tool 104.

Please replace the paragraph, beginning at page 6, line 10, with the following rewritten paragraph:

Optical imaging unit 102, such as a CCD imager, CMOS imager, or a camera, for example, is mounted above image plane 112<u>B</u> in order to receive an indirect image of bonding tool 104 through cornercube offset alignment tool 109. In another exemplary embodiment, a position sensitive detector (PSD), such as that manufactured by Ionwerks Inc., of Houston, TX, may also be used as optical imaging unit 102. In such an embodiment, when the hole in bonding tool 104 is illuminated, such as by using an optical fiber for example, the PSD can be utilized to record the position of the spot of light exiting bonding tool 104. It is also contemplated that the PSD may be quad cell or bi-cell detector, as desired.

Please replace the paragraph, beginning at page 6, line 19, with the following rewritten paragraph:

In the exemplary embodiment, the focal point of the vision system (coincident with imaginary plane 211 shown in Fig. 2A) is located above bottom surface 223 (shown in Fig. 2A) of cornercube 106. In addition, the exemplary embodiment includes two preferably

identical lens elements 108, 110 located at or below object plane 112A and image plane 112B. Another embodiment, shown in Fig. 2B, includes a single lens element 205 located below object plane 112A and image plane 112B and in line with optical axes 114, 116. Hereinafter, the combination of cornercube 106, and lens elements 108, 110 (or lens element 205) will be referred to as assembly 109.

Please replace the paragraph, beginning at page 6, line 27, with the following rewritten paragraph:

~~Image~~ The image plane ~~112~~ of cornercube 106, including lens elements 108, 110, is ~~positioned at~~ coincident with the object plane 112B of optical imaging unit 102. In other words, the image ~~object~~ plane of cornercube 106 and lens elements 108, 110 are aligned to bonding tool 104 which also lies in ~~image~~ object plane 112A. In the exemplary embodiment, lens elements 108, 110 (or 205) preferably have a unitary magnification factor. First lens element 108 is positioned in a first optical axis 114 between bonding tool 104 and cornercube 106. Second lens element 110 is substantially in the same plane as that of first lens element 108 and is positioned in a second optical axis 116 between optical imaging unit 102 and cornercube 106. In one exemplary embodiment, first and second optical axes 114 and 116 are substantially parallel to one another, and are spaced apart from on another based on specific design considerations of bonding machine 100. In one exemplary embodiment the distance 118 between first optical axis 114 and second optical axis 116 is about 0.400 in. (10.160 mm.) although distance 118 may be as small as about 0.100 in. (2.54 mm) depending on design considerations related to the bonding machine.

Please replace the paragraph, beginning at page 7, line 9, with the following rewritten paragraph:

Fig. 2A is a detailed side view of image ray traces and illustrates the general imaging concept of an exemplary embodiment of the present invention. In Fig. 2A, exemplary ray traces 210, 214 are separated for clarity to illustrate the relative immunity of the resultant image due to positional changes. The same distance also separates the image points because lens elements 108, 110 serve as unitary magnification relays. Fig. 2A also demonstrates how changes in the bonding tool 104 position are compensated for. For example, once conventional methods have been used to accurately measure the distance between imaging unit 102 and bonding tool 104 (shown in Fig. 1), the present invention is able to compensate for changes in the bonding tool 104 (or pick/place tool 114 discussed below with reference to Fig. 10A) offset position 222 due to changes in the system. The

location of bonding tool 104 can be accurately measured because cornercube 106 images bonding tool 104 onto image plane 112B of the optical system (not shown in this figure).

Please replace the paragraph, beginning at page 7, line 22, with the following rewritten paragraph:

The reference position of bonding tool 104 is shown as a reflected ray which travels from first position 202 along first optical axis 114 (shown in Fig. 1), as direct image ray bundle 210 from first position 202 through first lens element 108. Direct image ray bundle 210 continues along first optical axis 114 where it then passes through top surface 226 of cornercube 106 onto first internal reflection surface 218. Direct image ray bundle 210 is then reflected onto second internal reflection surface 220, which in turn directs it onto third internal reflective surface 221 (best shown in Fig. 3). Next, direct image ray bundle 210 travels back through top surface 226 of cornercube 106 as reflected image ray bundle 212 along the second optical axis 116 (shown in Fig. 1) and through second lens element 110 to image plane 112B. It is reflected image ray bundle 212 that is detected by imaging unit 102 as image 204.

Please replace the paragraph, beginning at page 8, line 1, with the following rewritten paragraph:

Consider now that the position of bonding tool 104 is displaced by a distance 222 due to a variation in system temperature, for example. As shown in Fig. 2A, the displaced image of bonding tool 104 is shown as position 206 and imaged along the path of second position ray trace 214. As shown in Fig. 2A, direct image ray bundle 214 travels along a path similar to that of direct image ray bundle 210 from first position 202. Second position 206 image travels as a direct image ray bundle 214, through first lens element 108. Direct image ray bundle 214 then passes through top surface 226 of cornercube 106 onto first internal reflection surface 218. Direct image ray bundle 214 is then reflected onto second internal reflection surface 220, which in turn directs it onto third internal reflection surface 221 (best shown in Fig. 3). Next, direct image ray bundle 214 travels through top surface 226 of cornercube 106 as reflected image ray bundle 216 and through second lens element 110 to image plane 112B. Reflected image ray bundle 216 is viewed as a reflected image by imaging unit 102 as being in second position 208. Although the above example was described based on positional changes along the X axis, it is equally applicable to changes along the Y axis.

Please replace the paragraph, beginning at page 8, line 25, with the following rewritten paragraph:

Referring again to Fig. 2A, vertex 228 (shown in phantom) of cornercube offset alignment tool 109 is located at a position approximately midway between first optical axis 114 and second optical axis 116. To facilitate mounting of cornercube 106, a lower portion 235 of the cornercube may be removed providing bottom surface 223, which may be substantially parallel to top surface 226. Removal of lower portion 235 does not affect the reflection of image rays since the image rays emanating from ~~image~~ object plane 112A do not impinge upon bottom surface 223.

Please replace the paragraph, beginning at page 9, line 30, with the following rewritten paragraph:

Fig. 3 is a perspective view of image ray traces according to an exemplary embodiment of the present invention translated in a direction perpendicular to the separation of lens elements 108, 110. The same image properties shown in Fig. 2A are also evident in Fig. 3. For example, the reference position of bonding tool 104 is represented by first position 302 and its image 304 is viewed as a first direct image ray 310 which travels along first optical axis 114 through first lens element 108; passes through top surface 226 of cornercube 106; strikes first reflective surface 218 of cornercube 106; travels through cornercube 106 in a path parallel to top surface 226; strikes second reflective surface 220; strikes third reflective surface 221 before exiting the cornercube 106 through top surface 226 and travels along second optical axis 116 through second lens element 110 onto image plane 112B as ray traces 312 and viewed by imaging unit 102 at position 304. Positional displacement of bonding tool 104 is also shown in Fig. 3 and is illustrated by the path of the ray traces 314, 316 from second position 306 to second viewed position 308.

Please replace the paragraph, beginning at page 10, line 11, with the following rewritten paragraph:

Figs. 4A-4B are perspective and side views, respectively, of an exemplary embodiment of the present invention illustrating lens elements 108, 110 and cornercube 106. The two lens elements 108, 110 (or 205) are preferably doublets located above the cornercube 106 based on their focal distance from object pane 112A and image plane 112B, and imaginary plane 211. Doublets are preferred based on their superior optical qualities. As illustrated in Figs. 4A-4B, an exemplary embodiment of cornercube 106 has three

internal reflective surfaces, 218, 220 and 221. As shown in Fig. 4B, the exterior edges of lens elements 108, 110 and cornercube 106 are coincident with one another.

Please replace the paragraph, beginning at page 10, line 19, with the following rewritten paragraph:

Fig. 5 illustrates the telecentricity of an exemplary embodiment of the image system of the present invention. As shown in Fig. 5, lens elements 108, 110 produce a unitary magnification and are arranged relative to cornercube 106 such that the telecentricity of the machine vision system is maintained. Note that front focal length 502 from lens element 108 to vertex 228 of cornercube 106 is equal to front focal 502 from lens element 110 to vertex 228 of cornercube 106. Note also, that back focal length 504 from lens element 108 to ~~image~~ object plane 112A is equal to back focal length 504 from lens element 110 to image plane 112B.

Please replace the paragraph, beginning at page 11, line 7, with the following rewritten paragraph:

Figs. 7A-7C illustrate the effect of tilt about the orthogonal axes of cornercube offset alignment tool 109 in an exemplary vision system. Fig. 7A is an overhead view of lens elements 108, 110 and cornercube 106. Exemplary image origins, 702, 703, 704, 706, 707, and 708 correspond to ~~the position~~positions of image ray traces 210, 214 (shown in Fig. 2A). Note that optic axis position 710 corresponds to the position where the image of bonding tool 104 (shown in Fig. 1) would be if cornercube 106 was not tilted along the Z axis.

Please replace the paragraph, beginning at page 11, line 17, with the following rewritten paragraph:

Figs. 8A-8C illustrate the effect of tilt about the X and Y axis of the exemplary vision system. Fig. 8A is an additional side view of exemplary image ray traces 210, 212, 214, 216. In Fig. 8A, arrow 804 and dot 802 are used to depict the X and Y axes, respectively and arrow 806 depicts tilt.

Please replace the paragraph, beginning at page 11, line 25, with the following rewritten paragraph:

Fig. 9 is a detailed side view of image ray traces according to a third exemplary embodiment of the present invention. In Fig. 9, the reference position of bonding tool 104 is shown as a reflected ray which travels from first position 914 (on ~~image~~ object plane 112A) along first optical axis 114 (shown in Fig. 1), as direct image ray bundle 922 from first position 914 through lens element 902. Note that in this exemplary embodiment, lens element 902 has a relatively planar, upper surface 904 and a convex lower surface 906. Direct image ray bundle 922 continues along first optical axis 114 where it then passes through upper surface 904 of lens element 902, and in turn through convex surface 906. Direct image ray bundle 922 is then reflected onto total reflective surface 908. In a preferred embodiment, total reflective surface 908 is a mirror. Next, direct image ray bundle 922 travels back through lens element 902 as reflected image ray bundle 920 along second optical axis 116 (shown in Fig. 1) and onto image plane 112B. It is reflected image ray bundle 920 that is detected by imaging unit 102 (shown in Fig. 1) as image 912. Similarly, positional displacement of bonding tool 104 is also shown in Fig. 9 and is illustrated by the path of direct image ray bundles 918, 924 from second position 910 to second viewed position 916.

Please replace the paragraph, beginning at page 12, line 10, with the following rewritten paragraph:

Referring to Fig. 10A, a ~~perspective~~side view of yet another exemplary embodiment of the present invention is illustrated. In Fig. 10A, vision system 1000 comprises multiple cornercube offset tools 1014, 1020, 1026 and respective lens sets 1016/1018, 1022/1024, 1028/1030, are used as an alignment means to improve the accuracy of die attach and pick/place of assemblies, such as die 1008, 1010, 1012. This will, in effect, replace a conventional up-looking camera (i.e., a die camera – not shown) found in most conventional mid to high accuracy placement (die attach and pick/place) equipment. In the exemplary embodiment, ganged multiple cornercubes 1014, 1020, 1026 with varied lens separation distances, 1017, 1023, 1029, respectively, provide an indirect image of a location of die 1008, 1010, 1012, respectively. It is understood by those of skill in the art that only one die is viewed at a time. The use of multiple cornercube offset tool/lens combinations allows for use with a variety of different sized die. In other respects, such as the materials used, the method of reflection, etc., this exemplary embodiment is similar to the first exemplary embodiment.

Please replace the paragraph, beginning at page 12, line 24, with the following rewritten paragraph:

As mentioned above, this variation of the first exemplary embodiment accommodates various die sizes which these types of equipment are required to accept and place. In this exemplary embodiment, down looking optical detector 1002, such as a camera, (i.e., a substrate camera) views features on the downward side of the component to be placed, such as die, 1008, ~~1101~~1010, or 1012. These features of die 1008, 1010, 1012, can then be identified via a vision system (not shown) to accurately place the die on the substrate (not shown) using pick tool 1004 based in part on the predetermined distance 1006 between pick/place tool 1004 and optical detector 1002. It is understood by those of skill in the art, that pick tool 1004 may be either a rotating or non-rotating pick tool. This exemplary embodiment further preserves the optical advantages with respect to accuracy of the cornercube alignment described above in the first exemplary embodiment.